

WHAT IS CLAIMED IS:

1. A wavelength division multiplexed (WDM) optical network, comprising:
a plurality of optical transmitters, each optical transmitter generating a data signal sent over a respective one of a plurality of signal channels, the plurality of signal channels being divided into a number of sub-bands where each sub-band includes at least two signal channels;

a plurality of substitute signal transmitters, the number of substitute signal transmitters being equal to the number of sub-bands, each substitute signal transmitter generating a substitute signal which provides loading in a corresponding sub-band;

a combining circuit which combines the data signals output from the plurality of optical transmitters and the substitute signals output from the plurality of substitute signal transmitters into a WDM signal; and

an optical transmission fiber which receives the WDM signal from the combining circuit.

2. A WDM optical network according to claim 1, further comprising:
a monitoring circuit which detects the wavelengths and power levels of each data signal in the WDM signal.

3. A WDM optical network according to claim 2, further comprising:
a control circuit, coupled to the monitoring circuit, which determines if a signal channel is unused or inoperable based on the detected wavelengths and power levels of the data signals detected by the monitoring circuit.

4. A WDM optical network according to claim 3, wherein the control circuit controls each of the plurality of substitute signal transmitters to be inoperative if all of the signal channels are receiving data signals from the plurality of optical transmitters.

5. A WDM optical network according to claim 3, wherein if one or more signal channels is determined to be unused or inoperable, the control circuit identifies the sub-band of the unused or inoperable signal channel and turns on the substitute signal transmitter corresponding to the identified sub-band.

6. A WDM optical network according to claim 5, wherein the control circuit adjusts the power of the turned-on substitute signal transmitter depending on the number of unused or inoperable signal channels in the identified sub-band.

7. A WDM optical network according to claim 3, wherein the control circuit determines how many signal channels in each of the sub-bands are unused or inoperable, and turns on a substitute signal transmitter corresponding to a particular sub-band if the number of signal channels in the particular sub-band exceeds a predetermined number.

8. A WDM optical network according to claim 1, further comprising:
a plurality of backup transmitters, the number of backup transmitters being less than the number of substitute signal transmitters.

9. A WDM optical network according to claim 1, wherein there is one backup transmitter corresponding to each pair of substitute signal transmitters.

10. A WDM optical network according to claim 9, wherein a control circuit detects a fault in a substitute signal transmitter based on detected wavelengths and power levels of the substitute signals detected by a monitoring circuit, and turns on a backup transmitter corresponding to the substitute signal transmitter in which the fault is detected.

11. A WDM optical network according to claim 10, wherein the control circuit adjusts the power of the backup transmitter based on whether a fault has been detected in one or both of the pair of substitute signal transmitters corresponding to the backup transmitter.

12. A WDM optical network according to claim 3, wherein the control circuit determines if there is any wavelength drift in the substitute signals output from the

substitute signal transmitters based on the detected wavelengths and power levels of the substitute signals detected by the monitoring circuit.

13. A WDM optical network according to claim 12, wherein if a substitute signal transmitter is determined to have wavelength drift, the control circuit adjusts a temperature of the substitute transmitter to compensate for the wavelength drift.

14. A WDM optical network according to claim 1, wherein the number of optical transmitters is at least 128 and the number of sub-bands is no more than 48.

15. A WDM optical network according to claim 1, further comprising:
a plurality of optical fiber splices, each optical fiber splice coupling a respective one of the plurality of substitute transmitters to the combining circuit.

16. A WDM optical network according to claim 15, wherein each optical fiber splice imposes an amount of insertion loss, which attenuates the power of the substitute signals output from each of the substitute signal transmitters.

17. A WDM optical network according to claim 16, wherein the amount of insertion loss imposed by the optical fiber splices coupled to substitute signal transmitters outputting substitute signals at shorter wavelengths is less than the amount of insertion loss imposed by the optical fiber splices coupled to substitute signal transmitters outputting substitute signals at longer wavelengths.

18. The WDM optical network according to claim 14, wherein the number of signal channels within each sub-band is at least 12.

19. The WDM optical network according to claim 1, wherein a laser is associated with each of said plurality of substitute signal transmitters, said laser having a frequency which is approximately halfway between a shortest frequency and a largest frequency in the corresponding sub-band.

20. A wavelength division multiplexed (WDM) terminal unit, comprising:

a plurality of optical transmitters, each optical transmitter generating a data signal sent over a respective one of a plurality of signal channels, the plurality of signal channels being divided into a number of sub-bands where each sub-band includes at least two signal channels;

a plurality of substitute signal transmitters, the number of substitute signal transmitters being equal to the number of sub-bands, each substitute transmitter generating a substitute signal which provides loading in a corresponding sub-band; and

a combining circuit which combines the data signals output from the plurality of optical transmitters and the substitute signals output from the plurality of substitute signal transmitters into a WDM signal.

21. A WDM terminal unit according to claim 20, further comprising:
a monitoring circuit which detects the wavelengths and power levels of each data signal in the WDM signal.

22. A WDM terminal unit according to claim 21, further comprising:
a control circuit, coupled to the monitoring circuit, which determines if a signal channel is unused or inoperable based on the detected wavelengths and power levels of the data signals detected by the monitoring circuit.

23. A WDM terminal unit according to claim 22, wherein the control circuit controls each of the plurality of substitute signal transmitters to be inoperative if all of the signal channels are receiving data signals from the plurality of optical transmitters.

24. A WDM terminal unit according to claim 22, wherein if one or more signal channels is determined to be unused or inoperable, the control circuit identifies the sub-band of the unused or inoperable signal channel and turns on the substitute signal transmitter corresponding to the identified sub-band.

25. A WDM terminal unit according to claim 24, wherein the control circuit adjusts the power of the turned-on substitute signal transmitter depending on the number of unused or inoperable signal channels in the identified sub-band.

26. A WDM terminal unit according to claim 22, wherein the control circuit determines how many signal channels in each of the sub-bands are unused or inoperable, and turns on a substitute signal transmitter corresponding to a particular sub-band if the number of signal channels in the particular sub-band exceeds a predetermined number.

27. A WDM terminal unit according to claim 20, further comprising:
a plurality of backup transmitters, the number of backup transmitters being less than the number of substitute transmitters.

28. A WDM terminal unit according to claim 20, wherein there is one backup transmitter corresponding to each pair of substitute signal transmitters.

29. A WDM terminal unit according to claim 28, wherein a control circuit detects a fault in a substitute signal transmitter based on detected wavelengths and power levels of the substitute signals detected by a monitoring circuit, and turns on a backup transmitter corresponding to the substitute signal transmitter in which the fault is detected.

30. A WDM terminal unit according to claim 29, wherein the control circuit adjusts the power of the backup transmitter based on whether a fault has been detected in one or both of the pair of substitute signal transmitters corresponding to the backup transmitter.

31. A WDM terminal unit according to claim 22, wherein the control circuit determines if there is any wavelength drift in the substitute signals output from the substitute signal transmitters based on the detected wavelengths and power levels of the substitute signals detected by the monitoring circuit.

32. A WDM terminal unit according to claim 31, wherein if a substitute signal transmitter is determined to have wavelength drift, the control circuit adjusts a temperature of the substitute signal transmitter to compensate for the wavelength drift.

33. A WDM terminal unit according to claim 20, wherein the number of optical transmitters is at least 128 and the number of sub-bands is no more than 48.

34. A WDM terminal unit according to claim 20, further comprising:
a plurality of optical fiber splices, each optical fiber splice coupling a respective one of the plurality of substitute transmitters to the combining circuit.

35. A WDM terminal unit according to claim 34, wherein each optical fiber splice imposes an amount of insertion loss, which attenuates the power of the substitute signals output from each of the substitute signal transmitters.

36. A WDM terminal unit according to claim 35, wherein the amount of insertion loss imposed by the optical fiber splices coupled to substitute signal transmitters outputting substitute signals at shorter wavelengths is less than the amount of insertion loss imposed by the optical fiber splices coupled to substitute signal transmitters outputting substitute signals at longer wavelengths.

37. The WDM terminal unit according to claim 33, wherein the number of signal channels within each sub-band is at least 12.

38. The WDM terminal unit according to claim 20, wherein a laser is associated with each of said plurality of substitute signal transmitters, said laser having a frequency which is approximately halfway between a shortest frequency and a largest frequency in the corresponding sub-band.

39. A combiner circuit for combining wavelength channels comprising:
a first combiner unit for combining a first plurality of said wavelength channels to generate a first combined set of wavelength channels;
a second combiner unit for combining a second plurality of said wavelength

channels which are outside the band of said first plurality to generate a second combined set of wavelength channels; and

an interleaver for receiving and combining said first and second combined sets of wavelength channels to output a third combined set of wavelength channels.

40. The combiner circuit of claim 39, wherein said first and second combining units are arrayed waveguides (AWGs).

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